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The Influence of Environmental Management Practices and Supply Chain Integration on Technological Innovation Performance

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Abstract: *The increasing demands for sustainability and enacting environmental regulations have made companies increasingly employing environmental management practices (EMPs) together with supply chain integration (SCI) to increasingly support technological innovation performance (TIP). This conceptual paper proposes a framework for the analysis of the direct effects of EMPs on TIP, which include mediating and moderating effects via SCI. In particular, based on RBV, NRBV, Dynamic Capabilities, and Knowledge-Based Views, the model states that EMPs create avenues for innovations based on resource efficiency and sustainable capability development, while SCI can further assist by facilitating knowledge transfer and collaboration among all internal functions and external partners. Three propositions are developed: (1) EMPs positively influence TIP; (2) SCI mediates the influence of EMPs on TIP by providing a channel for environmental knowledge; and (3) SCI moderates the EMP-TIP relationship such that higher levels of integration enhance the effect. This framework contributes to the theoretical advancement by integrating SCI as a key dynamic capability in NRBV and providing a holistic view of the sustainable innovation problem. In terms of practical implications, this calls for integrating EMPs with high levels of SCI for better innovation outcomes. Future empirical research should seek to test the propositions via SEM in manufacturing contexts by explicitly positioning supply chain integration as both a mediating and moderating mechanism, this study responds to calls for multi-theoretical explanations of sustainable technological innovation..*

Keywords: *Dynamic Capabilities, Environmental Management Practices, Natural Resource-Based View, Supply Chain Integration, Sustainable Innovation, Technological Innovation Performance*

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1.0 Introduction

Machine Learning (ML) and Artificial Intelligence (AI) entered the stage of revolutionizing the interdisciplinary sectors by offering reliable answers to the problems of data interpretation, real-time decision-making, and self- navigating (Areghan & Ndibe, 2024). Driven by escalating climate-related challenges, stakeholder expectations, and regulatory pressures, businesses across the globe are increasingly prioritizing sustainability as a core operational and strategic imperative. Recent regulatory developments, such as revisions to the ISO 14001 environmental management standard, increasingly emphasize climate action, risk management, and the integration of environmental considerations into core organizational processes (Camilleri, 2022). According to Ademilua & Areghan (2022), these latest developments are paralleled by the ongoing changes at broader levels, including those given in the directive that was promulgated in the EU as Corporate Sustainability Reporting Directive (CSRD) that are partly implementing decarbonization and resource efficiency in national policies. The increasing demands place firms under pressure from the variety of environmental challenges, such as scarcity of resources and targets for reducing emissions/. Technological innovation emerges as a primary response: using revolutionary technological applications for developing cleaner processes, sustainable products, and resilient operations in the face of these exigencies. Within this context, firms are compelled to adopt structured environmental management practices not merely for compliance, but as strategic tools for long-term competitiveness and innovation

An expanding body of empirical evidence suggests that environmental management practices (EMPs), when aligned with organizational and inter-organizational processes, contribute significantly to improved firm performance outcomes (Obamen et al., 2021). Need still exists in understanding the combined influence of such initiatives on technological innovation performance (TIP). Previous research has demonstrated that EMPs, like eco-design and green procurement, enhance innovation in terms of resource efficiency and knowledge creation (Arapha, 2022; Abolade, 2023). In a similar manner, SCI provides an enabling environment for collaboration and information sharing as such supports innovation diffusion. However, despite extensive empirical research on EMPs and SCI as independent drivers of performance, limited conceptual attention has been given to how these constructs interact—particularly through mediating and moderating mechanisms—to influence technological innovation performance.

Addressing these limitations, this study develops a theoretically grounded conceptual framework that integrates EMPs, SCI, and technological innovation performance within a unified explanatory model. Based on a Resource-Based View (RBV) and a Natural Resource-Based View (NRBV), the model investigates direct EMP-TIP relations and the mediating and moderating roles of SCI in strengthening these relationships. While RBV and NRBV explain how environmentally oriented resources and capabilities generate competitive advantage, dynamic capabilities and knowledge-based perspectives highlight the role of SCI in reconfiguring these resources through inter-organizational learning and collaboration. Specifically, SCI is conceptualized as a mediating mechanism by which environmental knowledge generated through EMPs is transferred and operationalized across organizational boundaries, and as a moderating capability that amplifies the effectiveness of EMPs in driving technological innovation outcomes.

Accordingly, the study pursues three interrelated objectives: (1) to develop a conceptual model integrating EMPs, SCI, and technological innovation performance; (2) to formulate theoretically grounded propositions for future empirical validation; and (3) to derive managerial and policy-relevant insights for innovation-driven sustainable supply chains By positioning supply chain integration as a dynamic capability within the natural resource-based view, this study advances sustainable supply chain and innovation literature and offers actionable guidance for managers seeking to align environmental strategies with technological innovation performance.

The structure of the paper is as follows: Section 2 reviews the relevant literature and theoretical foundations. Section 3 presents the conceptual framework, key constructs, propositions, and visual representations. Section 4 discusses theoretical contributions, managerial implications, limitations, and avenues for further research. Finally, Section 5 summarizes the key insights.

2. 0 Literature Review

2.1 Definition of Environmental Management Practices (EMPs)

According to Rathi (2019), Environmental Management Practices (EMPs) refer to systematic organizational initiatives aimed at minimizing adverse environmental impacts while simultaneously enhancing operational efficiency and long-term sustainability. EMPs are commonly conceptualized as comprising both internal and external dimensions. EMPs are typically internal and external phenomena.

Internal EMPs refer to environmentally oriented activities implemented within the organizational boundaries of a firm (Bamidele, 2023), including eco-design, pollution prevention, cleaner production techniques, and environmental management systems such as ISO 14001 certification. Collectively, these initiatives enhance resource efficiency, reduce operational costs, ensure regulatory compliance, and strengthen firms' environmental legitimacy. xternal EMPs extend beyond firm boundaries and involve collaboration with supply chain partners to achieve shared environmental objectives (Bamidele et al., 2023) Examples include green supplier selection, joint environmental programs with suppliers, and collaborative carbon footprint reduction initiatives across the value chain. These practices entail sharing responsibility for sustainability and fostering the incorporation of environmentally friendly technologies and processes in the entire network (Sanni, 2023, Nsikan, *et al*., 2022; Sanni, 2024). Generally, EMPs enable organizations to proactively respond to regulatory and stakeholder pressures while building long-term competitive advantage through sustainable innovation.

EMPs have ecological risk mitigation potentials, as they create windows for innovations (Odeyemi, 2022). They also forge competencies toward sustainable resource management and ensure that organizations lead in green practices, thus laying a foundation for improved technological innovation performance that is said to be consistent across Hemba & Phil-Eze (2021).

Fig. 1 illustrates the key dimensions of Environmental Management Practices (EMPs), highlighting the distinction between internal and external environmental initiatives adopted by firms. Internal EMPs include practices such as eco-design, cleaner production, pollution prevention, and environmental management systems, while external EMPs emphasize collaboration with supply chain partners through green procurement, supplier environmental assessment, and joint sustainability programs. The figure demonstrates how the integration of these practices enables organizations to reduce environmental risks, improve resource efficiency, and create a foundation for sustainable technological innovation (Green Element, 2023).

Supply Chain Integration (SCI) refers to the extent to which a firm strategically coordinates, collaborates, and shares information with internal functions and external supply chain partners. It can be subdivided into internal integration and external integration. Internal SCI involves cross-functional alignment among departments such as marketing, research and development, production, and logistics to facilitate seamless information flow and coordinated decision-making.

This internal cohesion reduces silos, increases responsiveness, and facilitates rapid implementation of new ideas and technologies. External SCI extends this coordination beyond the firm to include upstream suppliers and downstream customers through collaborative planning, shared forecasting, joint problem-solving, and product co-development (Ademilua & Areghan, 2022). This means including supply integration, such as collaborative planning, shared forecasts, and joint problem-solving, and customer integration through co-development of products and feedback loops. According to Hunold & Shekhar (2022), these relationships enhance visibility, trust, and joint capabilities within the supply chain. High degrees of external SCI allow firms to draw on partners' resources and knowledge, which is particularly useful in dynamic and uncertain environments.

In conclusion, SCI is a strategic capability that enhances relational ties and information sharing. Pawar et al. (2021) argued that by strengthening collaboration and reducing informational barriers, SCI facilitates the diffusion of best practices and innovation, thereby enhancing technological and operational performance

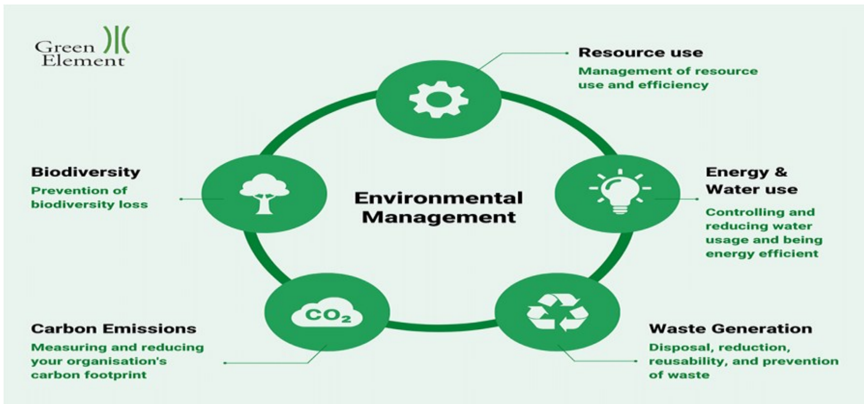

Fig. 1: Environmental Management Practices (Green Element. 2023)

2.2 Definition of Supply Chain Integration (SCI)

2.3 Definition of Technological Innovation Performance (TIP)

Technological Innovation Performance (TIP) reflects the effectiveness with which a firm develops, adopts, and commercializes new or significantly improved technologies, products, and processes (Zhao et al., 2024). The most common measures of this concept include the number of new products introduced, success rates for process innovations, R&D efficiencies such as time-to-market or cost cuts, patent applications and approvals, and the overall innovation performance in the market. Accordingly, TIP captures both the quantity and quality of technological advancements achieved by a firm (Ganda, 2019).

According to Ahmadu (2021), in practice, there are two major types of TIP-product innovation, which means developing new or improved offerings; and process innovation, which refers to improving production methods or operational efficiencies. With such high levels of TIP, firms would be able to provide competitive advantage through differentiation, cost leadership, as well as market responsiveness (Ukpabio *et al*., 2020). This dimension is particularly critical in sustainability contexts, where technological innovations often focus on eco-efficient processes, environmentally friendly products, and circular economy solutions).

Finally, this serves as a measurement criterion against which firms would be ranked in translating strategic investments into tangible technological breakthroughs, such as their use of environmental practices and supply chain collaboration (Obialo & Akinjo, 2021; Nwaobi, 2024). This substantiates the fact that any kind of innovation is the gateway to long-term competitiveness in sustainability.

Fig. 2 presents the core dimensions of Technological Innovation Performance (TIP), capturing both product and process innovation outcomes within organizations. The figure illustrates how TIP is reflected in the development of new or improved products, enhancements in production processes, increased R&D efficiency, reduced time-to-market, and improved commercialization success. It further emphasizes the role of technological innovation as a driver of competitive advantage, operational efficiency, and sustainability-oriented performance, particularly in environments characterized by rapid technological change and environmental pressures (Brynjolfsson & McAfee, 2014).

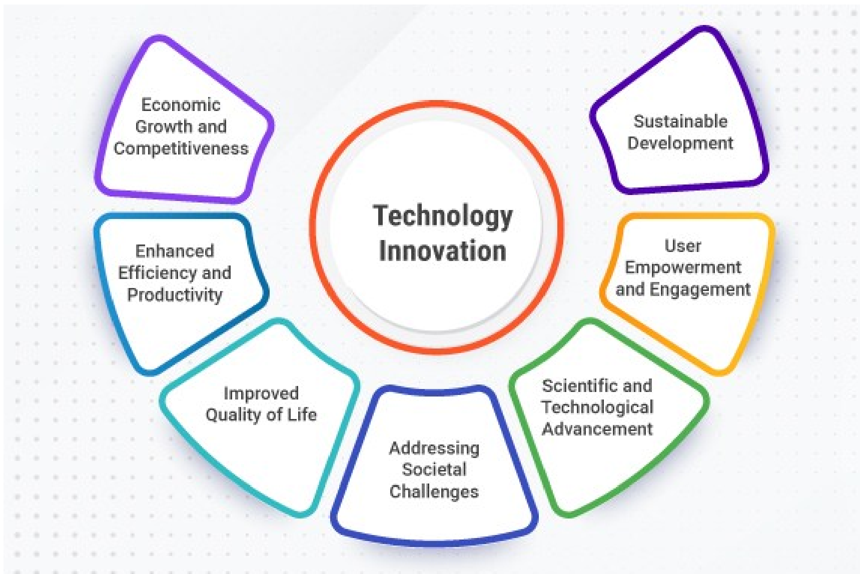

Fig. 2: Technological Innovation Performance (Brynjolfsson & McAfee, 2014)

2.4 Theoretical Foundations

The conceptual framework that this paper proposes is based largely on two complementary theoretical lenses: the Resource-Based View (RBV) and Natural Resource-Based View (NRBV). The RBV states that firms obtain sustained competitive advantage from possessing valuable, rare, inimitable, and non-substitutable resources and capabilities (Varadarajan, 2023). Within this framework, EMPs and SCI are conceptualized as strategic resources and capabilities that jointly contribute to superior innovation performance. According to McDougall *et al.* (2019), NRBV extends RBV by addressing environmental constraints and contending that environmental proactive strategies such as pollution prevention and product stewardship create special capabilities that lead to competitive advantage including innovation. The framework also combines Dynamic Capabilities and the Knowledge-Based View. Dynamic Capabilities amplify the firm's ability to integrate, build, and reconfigure internal and external competences as required by the dynamic environments (Akpan, *et al*., 2022). Through rapid adaptation and reconfiguration of internal and external knowledge, SCI functions as a dynamic capability that enables firms to respond effectively to environmental and technological changes.

According to Yu *et al*. (2024), the Knowledge-Based View emphasizes that knowledge is probably the most strategically important resource, facilitating creation, transfer, and application through SCI-which can be said key drivers of technological innovation. Srivastava & Mir (2023) proposed that these theories form a strong basis for understanding the course through EMPs and SCI in influencing TIP. Collectively, these theoretical perspectives highlight the synergistic roles of internal capabilities, inter-organizational relationships, and knowledge flows in shaping sustainable technological innovation outcomes.

2.5 Synthesis of Prior Work

Previous studies have shown that EMPs, including resource efficiency initiatives, waste minimization, and green technology development, exert a positive influence on technological innovation performance. For example, internal practices such as eco-design and pollution prevention have been linked to enhanced product development capabilities and higher levels of innovation, as firms gain experience in utilizing sustainable materials and processes.

Likewise, SCI has been characterized as a strong promoter of knowledge transfer and collaborative innovation. An integrated supply chain transfers technical knowledge, market insights, and best practices, thus speeding up innovation diffusion and the co-creation of novel solutions. As noted before, it is particularly thought that external integration engenders good research-to-development outcomes and patent generation.

However, existing literature largely examines EMPs and SCI in isolation, with limited conceptual integration explaining how these constructs jointly influence technological innovation performance.

This gap underscores the need for a harmonized conceptual framework that elucidates the mediating and moderating roles of supply chain integration in translating environmental management practices into sustainable technological advancement.

3.0 Conceptual Framework and Propositions

This section presents the conceptual framework underpinning the study and develops theoretically grounded propositions that explain the relationships among Environmental Management Practices (EMPs), Supply Chain Integration (SCI), and Technological Innovation Performance (TIP).

Table 1 presents the definitions and key dimensions of the main constructs employed in the conceptual framework—Environmental Management Practices (EMPs), Supply Chain Integration (SCI), and Technological Innovation Performance (TIP). These definitions and dimensions are derived from well-established pre-2024 literature, ensuring conceptual consistency and alignment with prior empirical and theoretical work.

Table 1: Definitions and Dimensions of Key Constructs
editable format:

Construct	Definition	Key Dimensions	Representative Pre-2024 Sources
Environmental Management Practices (EMPs)	Systematic approaches to reduce environmental impact through policies and processes	Internal (e.g., eco-audits, cleaner production); External (e.g., green procurement)	Xue et al. (2020); Bristol-Alagbariya et al. (2022)
Supply Chain Integration (SCI)	Coordination and information sharing across internal functions and external partners	Internal (functional coordination); External (supplier/customer integration)	Solaimani & van der Veen (2022); Tan et al. (2023)
Technological Innovation Performance (TIP)	Outcomes from innovation efforts in technology, products, and processes	Product innovation; Process innovation; Speed and success metrics	Ezeigweneme et al. (2023)

**** Definitions and Dimensions of Key Constructs (Bristol-Alagbariya *et al.*, 2022)**

Structured presentation of key constructs in the conceptual framework: Environmental Management Practices (EMPs), Supply Chain Integration (SCI), and Technological

Innovation Performance (TIP). Each construct is briefly defined; key dimensions follow, confirmed with relevant pre-2024 sources that have greatly influenced the literature. This table thus becomes of primary significance for conceptual materiality, congruent with prior work and therefore facilitating the construction of the proposed model.

Environmental Management Practices (EMPs) are conceptualized as systematic and proactive approaches through which firms manage their environmental impacts by embedding sustainability considerations into organizational policies, processes, and routines. This definition captures the preemptive and structured nature of the practices, which, beyond compliance-oriented activities, are considered toward strategic environmental stewardship. Consistent with prior literature, EMPs encompass both internal practices (e.g., eco-audits, pollution prevention, and waste minimization) and external practices (e.g., green procurement, supplier environmental assessment, and collaborative sustainability initiatives with supply chain partners). Key sources include: Xue, *et al*., (2020) who empirically linked EMPs to innovation outcomes in manufacturing, and Bristol- Alagbariya, *et al*., (2022) who developed a seminal framework on sustainable supply chain management that has shaped much subsequent literature on external environmental collaboration.

Supply Chain Integration (SCI) is defined as the degree of strategic coordination, collaboration, and information sharing among internal organizational functions and external supply chain partners. This definition highlights the dual role of SCI in fostering intra-organizational alignment and inter-organizational relationships. Key dimensions include internal integration (e.g., cross-functional coordination between departments such as R&D, production, and procurement) and external integration (e.g., collaborative planning with suppliers and customers). These dimensions are supported by seminal studies such as Solaimani and van der Veen (2022), who conceptualized integration arcs and demonstrated their performance implications, and Tan et al. (2023), who showed how SCI enhances knowledge flows and operational synergy.

The third construct, Technological Innovation Performance (TIP), refers to the outcomes of innovation efforts in technology, product, and process. This outcome-oriented definition emphasizes the assessment of realized innovation outputs rather than innovation inputs. Key dimensions include product innovation (development of a new or improved offering), process innovation (advances in methods of production or technology). Consequently, common performance metrics include time-to-market, R&D effectiveness, patent outputs, and market acceptance rates. In the table, references are given for Pawar, *et al*., (2021) who examined the determinants of eco-innovation among European firms as well as Ezeigweneme, *et al*., (2023) who specifically associated environmental practices and innovation performance thus providing empirical justification for the relevance of these dimensions within sustainability contexts.

Table 2 summarizes the proposed relationships among Environmental Management Practices (EMPs), Supply Chain Integration (SCI), and Technological Innovation Performance (TIP), alongside their underlying theoretical foundations and expected directional effects. Specifically, the table consolidates the three core propositions (P1–P3) developed in this study, clearly distinguishing the direct, mediating, and moderating roles of SCI within the conceptual framework. By aligning each proposition with established theoretical lenses—namely the Resource-Based View (RBV), Natural Resource-Based View (NRBV), Knowledge-Based View, Dynamic Capabilities, and Contingency Theory—Table 2 provides a structured and theory-driven overview of how environmental management initiatives are expected to translate into superior technological innovation outcomes. Overall, the table serves as an integrative bridge between the literature review and the proposed conceptual model, offering a concise interpretation of the hypothesized mechanisms through which EMPs and SCI jointly influence TIP.

Table 2: Summary of Proposed Relationships and Theoretical Support

Proposition	Description	Theoretical Basis	Expected Direction
P1	Environmental Management Practices (EMPs) have a positive direct effect on Technological Innovation Performance (TIP).	Resource-Based View (RBV) / Natural Resource-Based View (NRBV)	Positive
P2	Supply Chain Integration (SCI) positively mediates the relationship between Environmental Management Practices (EMPs) and Technological Innovation Performance (TIP).	Knowledge-Based View / Dynamic Capabilities	Positive mediation
P3	Supply Chain Integration (SCI) positively moderates the relationship between Environmental Management Practices (EMPs) and Technological Innovation Performance (TIP), such that stronger SCI enhances the effect.	Dynamic Capabilities / Contingency Theory	Positive moderation

(Source : (Huo, Gu & Wang, 2022)

Based on the theoretical foundations discussed earlier, three propositions (P1–P3) are formulated to explain the direct, mediating, and moderating relationships among EMPs, SCI, and TIP. These propositions provide a logical bridge between the literature review and the proposed conceptual model. A discussion on the directional expectations against TIP associated with these propositions will follow. From an external standpoint, the propositions can be viewed, alongside their respective rationales for acceptance or rejection, as a helpful shortcut to linking both the literature review and proposed model contingent on the hypothesized relationships and their theoretical constructs.

Proposition 1 (P1): *Environmental Management Practices (EMPs) have a positive and direct effect on Technological Innovation Performance (TIP).* This proposition builds heavily on the Resource-Based View and Natural Resource-Based View. According to Matsoso (2023), EMPs are those resources that can generate sustained competitive advantages while being valuable, rare, and hard to imitate (these resources include eco-design capabilities, pollution prevention systems, etc.). Dada *et al*. (2024) further argue that NRBV makes proactive environmental strategies to create unique capabilities that directly promote innovation, such as developing cleaner technologies or sustainable products. Accordingly, higher levels of EMP adoption are expected to translate into superior technological innovation outcomes (Utomi *et al*., 2024).

Proposition 2 (P2): *Supply Chain Integration (SCI) positively mediates the relationship between Environmental Management Practices (EMPs) and Technological*

Innovation Performance (TIP). The investigation of this mediation is deepened by the perspectives offered by the Knowledge-Based View and Dynamic Capabilities. Osobajo and Bjeirmi (2021) maintained that knowledge-Based View holds knowledge on the most strategically significant resource, whereas Dynamic Capabilities underline the firm's ability to reconfigure resources in response to environmental changes. In this context, sustainability-related knowledge generated through EMPs is disseminated, recombined, and amplified through the coordination and information-sharing mechanisms enabled by SCI. knowledge related to sustainability is generated from the EMPs such as eco-friendly materials or processes, which is later disseminated and amplified through the coordination and information-sharing mechanisms of SCI. From the literature, through SCI, EMP-generated knowledge is subsequently converted into tangible technological innovations, thus acting as a mediator (Lyu *et al*., 2022). The expected outcome is positive mediation, which implies that the effect of EMPs on TIP is either partially or fully mediated through enhanced SCI.

Proposition 3 (P3): *Supply Chain Integration (SCI) positively moderates the relationship between Environmental Management Practices (EMPs) and Technological Innovation Performance (TIP), such that the relationship is stronger at higher levels of SCI.*

This proposition relies on Dynamic Capabilities and Contingency Theory. Teece (2018), observed that Dynamic Capabilities justify the adaptation of SCI as a flexible mechanism to reinforce the internal resources like EMPs. On the other hand, Contingency Theory posits that the success of environmental strategies can be contingent to certain contextual factors, if characterized by a high degree of supply chain integration (Effah, 2024). Thus, strong supply chain integration enhances the effectiveness of environmental management practices in driving technological innovation outcomes. Abolade (2023) elaborated on the synergistic role of SCI to further leverage the innovation benefits arising from environmental management practices.

4. 0 Discussion

4.1 Theoretical Contributions

This paper advances the Natural Resource-Based View (NRBV) by explicitly incorporating Supply Chain Integration (SCI) as a complementary dynamic capability that links environmental strategies to technological innovation performance. It is worth noting that, while recommended in NRBV for drawing competitive advantage through capabilities that are unique to organizations as a result of proactive environmental practices such as pollution prevention, product stewardship, and sustainable development, the framework has traditionally addressed NRBV by focusing on firm internal resources (Ndibe & Ufomba, 2024). Positioning SCI as a complementary dynamic capability extends the NRBV beyond firm-level internal resources to include inter-organizational and network-based capabilities. It is possible to amplify and diffuse environmentally driven knowledge and resources among supply chain partners through SCI, thereby leading to better innovative outcomes from EMPs (Amougou, 2023).

The proposed model thus highlights that of SCI as a mediator and moderator, leading to a nuanced understanding of how sustainability strategies are transferred into technological innovation performance (TIP). The mediation proposition specifies that the knowledge derived from EMPs is conducted by SCI toward tangible innovation outputs, while the moderation effect indicates high setup levels of integration as a factor that magnifies the efficiency of environmental practices in terms of innovation (Olaleye *et al*., 2024). In this way, integrating SCI into the NRBV framework connects the previously segregated streams of literature on sustainable supply chain management and innovation to arrive at a more comprehensive theoretical vision of ways for reaching sustainable advantages in a reputedly environmentally constrained context (Aboagye *et al*., 2022). Generally, this extension shifts the NRBV from an inward-looking perspective toward a relational and network-oriented view of sustainable competitive advantage. The benefits of such advancement are well-timed today, especially as the assumption within policy is increasingly favoring collaborative sustainability initiatives and circular economy models, within which supply chain integration becomes key to innovation at the ecosystem level.

4.2 Managerial Implications

The findings underscore the importance of adopting an integrated approach to sustainability and innovation strategy. Managers should not see EMPs and SCI as different initiatives but rather as settings of mutually reinforcing levers. Organizations that embrace strong EMPs like eco-design, cleaner production, and green procurement alongside development of good levels of internal and external SCI stand a better chance of achieving exceptional technological innovation performance (Adeyemi, 2023). For instance, stronger supplier collaboration may aid in rapid acceptance of sustainable materials and technologies, while integrated information systems can support speedy knowledge sharing and co-innovation.

In practice, firms need to prioritize the building of cross-functional teams and to create collaborative platforms with key suppliers and customers for strengthening SCI (Adeyemi, 2024). This may include using joint planning tools, sharing sustainability performance data, and working on co-development projects. This way, organizations can convert meeting environmental obligations into being a competitive advantage for innovation, which will translate into shortened product-development cycles, increased process efficiencies, and a reinforced position in the marketplace for sustainability-oriented industries (Adeusi *et al*., 2024). The central message for managers is that isolated environmental activities may provide little innovation payback. Ultimately, combining robust environmental management practices with deliberate efforts to strengthen supply chain integration enables firms to achieve sustained technological renewal and long-term competitive advantage.

4.3 Limitations and Future Research

As a conceptual study, this research is limited by the absence of empirical validation. Although grounded in established theories, the relationship between EMPs, SCI, and TIP has not been tested against real-world data. Therefore, it limits both abilities to confirm and those to qualify strength, direction, and significance of the hypothesized effects and to include other possible contextual moderators like the industry type, firm size, or geographic region.

Empirical testing of the proposed framework should be the priority for future researches.

Future empirical studies could employ structural equation modeling (SEM) to simultaneously test direct, mediating, and moderating effects within the proposed framework.

This will facilitate the examination of direct, indirect, and conditional paths if researchers are interested in establishing these relationships simultaneously. Sectoral coverage on manufacturing could include electronics, automotive, or textiles, all of which show clear environmental pressures as well as supply chain complexity.

Such avenues include studies spanning over a long period of time to appreciate how these relationships change over time as well as comparisons across different cultural or regulatory contexts. It would validate the model but also refine it by identifying boundary conditions and additional mediating mechanisms, such as knowledge absorptive capacity or organizational learning.

5.0 Conclusion

This conceptual paper examined the interrelationships among Environmental Management Practices (EMPs), Supply Chain Integration (SCI), and Technological Innovation Performance (TIP), proposing a framework that highlights their synergistic effects. The analysis demonstrates that EMPs positively influence TIP by enhancing resource efficiency and sustainability-oriented capabilities, while SCI plays a pivotal mediating and moderating role in this relationship. Through mediation, SCI facilitates the transformation of environmental knowledge into commercialized technological innovations, and through moderation, it amplifies the innovation benefits of EMPs at higher levels of integration.

Grounded in the Resource-Based View, Natural Resource-Based View, Dynamic Capabilities, and Knowledge-Based View, the framework extends sustainability theory by emphasizing the importance of inter-organizational integration in converting environmental strategies into technological outcomes. In an environment characterized by regulatory pressure, resource constraints, and heightened stakeholder expectations, firms that strategically align EMPs with strong internal and external SCI are better positioned to achieve sustained technological advancement and competitive resilience.

Although the framework provides a strong conceptual foundation, empirical validation is required to assess its applicability across industries and contexts. Future research should employ methods such as structural equation modeling and longitudinal designs to test the proposed relationships. Overall, this study contributes to the sustainability and innovation literature by demonstrating how integrated environmental and supply chain strategies can drive meaningful technological innovation and long-term competitive advantage.

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Ademilua led the conceptual design and theoretical integration of RBV and NRBV. Olatunji developed the three propositions regarding EMPs and technological performance. Ehiorobo contributed to the practical implications for industrial sustainability and resource efficiency. Sanni assisted in refining the mediating and moderating framework for supply chain integration. Together, they established a holistic model for sustainable innovation.